| 1.  |   | 1.  |   | 28.  |   |
| 2.  |   | 2.  |   | 29.  |   |
| 3.  |   | 3.  |   | 30.  |   |
| 4.  |   | 4.  |   | 31.  |   |
| 5.  |   | 5.  |   | 32.  |   |
| 6.  |   | 6.  |   | 33.  |   |
| 7.  |   | 7.  |   | 34.  |   |
| 8.  |   | 8.  |   | 35.  |   |
| 9.  |   | 9.  |   | 36.  |   |
|10.  |   |10.  |   | 37.  |   |
|11.  |   |11.  |   | 38.  |   |
|13.  |   |13.  |   | 40.  |   |
|15.  |   |15.  |   |       |   |
|16.  |   |16.  |   |       |   |
|17.  |   |17.  |   |       |   |
|18.  |   |18.  |   |       |   |
|19.  |   |19.  |   |       |   |
|20.  |   |20.  |   |       |   |
|21.  |   |21.  |   |       |   |
|22.  |   |22.  |   |       |   |
|23.  |   |23.  |   |       |   |
|24.  |   |24.  |   |       |   |
|25.  |   |25.  |   |       |   |
|27.  |   |27.  |   |       |   |
Matching: Match the object in column A with the correct description in column B. Its in column B can be used only once. (1 point each)

<table>
<thead>
<tr>
<th>Column A</th>
<th>Column B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Main Sequence</td>
<td>A. planet with great blue spot, last planet visited by Voyager</td>
</tr>
<tr>
<td>2. Red giant</td>
<td>B. planet with 2/3 of surface covered with water</td>
</tr>
<tr>
<td>3. Supergiant</td>
<td>C. cool, red, faint star</td>
</tr>
<tr>
<td>4. White dwarf</td>
<td>D. hot, outermost layer of the Sun</td>
</tr>
<tr>
<td>5. Neutron star</td>
<td>E. energy source for Red Giant stars</td>
</tr>
<tr>
<td>6. Black Hole</td>
<td>F. remains of a planet that never formed</td>
</tr>
<tr>
<td>7. O main sequence star</td>
<td>G. heavily cratered planet</td>
</tr>
<tr>
<td>8. M main sequence star</td>
<td>H. appears as dark patch on surface of sun, varies on 11 year cycle</td>
</tr>
<tr>
<td>9. Blackbody</td>
<td>I. solar system objects composed mainly of ice and dirt</td>
</tr>
<tr>
<td>10. Corona</td>
<td>J. layer of the Sun where sunlight we see originates</td>
</tr>
<tr>
<td>11. Sun spot</td>
<td>K. planet with giant ring system made of tiny rocks and pieces of ice</td>
</tr>
<tr>
<td>12. Photosphere</td>
<td>L. hot, blue, luminous star</td>
</tr>
<tr>
<td>13. Planetary Nebula</td>
<td>M. stars that are burning Hydrogen into Helium</td>
</tr>
<tr>
<td>14. Hydrogen Fusion</td>
<td>N. end state of sun-like stars, supported by electron pressure</td>
</tr>
<tr>
<td>15. Helium Fusion</td>
<td>O. type of spectrum emitted by stars</td>
</tr>
<tr>
<td>16. Mercury</td>
<td>P. planet with red atmospheric storm, 2-3 times the size of earth</td>
</tr>
<tr>
<td>17. Venus</td>
<td>Q. end state of massive stars, made entirely of neutrons</td>
</tr>
<tr>
<td>18. Earth</td>
<td>R. considered a planet but probably a Kuiper belt object</td>
</tr>
<tr>
<td>19. Mars</td>
<td>S. created when outer layers of star are thrown off near end of its life</td>
</tr>
<tr>
<td>20. Jupiter</td>
<td>T. planet with hottest surface temperature</td>
</tr>
<tr>
<td>21. Saturn</td>
<td>U. what the Sun will become after Hydrogen fusion ends</td>
</tr>
<tr>
<td>22. Uranus</td>
<td>V. planet whose surface contains a lot of rusted iron</td>
</tr>
<tr>
<td>23. Neptune</td>
<td>W. star that is compressed to an infinitesimal point</td>
</tr>
<tr>
<td>24. Pluto</td>
<td>X. what an O star will become after Hydrogen fusion</td>
</tr>
<tr>
<td>25. Comets</td>
<td>Y. planet tipped on its side due to a collision with an earth-size object</td>
</tr>
<tr>
<td>26. Asteroids</td>
<td>Z. energy source for the Sun</td>
</tr>
</tbody>
</table>
Multiple Choice: Choose the letter that best answers each question. Write your answer on the answer sheet. (1 point each)

1. In the northern hemisphere, the sun reaches its highest point in the sky at 12 noon on which of the following dates?
   a. March 21st
   b. June 21st
   c. September 23rd
   d. December 21st

2. In the northern hemisphere, the stars rise in the
   a. East, set in the West and revolve anti-clockwise around the South celestial pole.
   b. East, set in the West and revolve clockwise around the South celestial pole.
   c. West, set in the East and revolve clockwise around the South celestial pole.
   d. West, set in the East and revolve anti-clockwise around the South celestial pole.

3. Precession is the
   a. accuracy with which numbers are given in astronomy.
   b. slow motion of the Earth's rotation axis on the celestial sphere.
   c. apparent backward motion of planets on the celestial sphere.
   d. daily eastward motion of the Sun around the celestial sphere.

4. The zenith distance of Polaris, the "North Star"
   a. is always 90 degrees.
   b. is always 23.5 degrees.
   c. is always 0 degrees.
   d. varies with your latitude.

5. Which is ordered from smallest to largest?
   a. centimeter, meter, kilometer, astronomical unit, light year.
   b. astronomical unit, centimeter, meter, kilometer, light year.
   c. light year, astronomical unit, kilometer, meter, centimeter.
   d. meter, centimeter, kilometer, light year, astronomical unit.

6. In the magnitude system, if star 1 appears fainter than star 2, then the apparent magnitude of star 1 is
   a. greater than the apparent magnitude of star 2.
   b. less than the apparent magnitude of star 2.
   c. the same as the apparent magnitude of star 2.

7. The constellations of the zodiac are special because
   a. the sun and planets move through them.
   b. they indicate a person’s general personality traits.
   c. they contain the brightest stars in the sky.
   d. they are all always visible in the night sky at any point during the year.

8. The Earth is tilted 23.5 degrees. If the Earth’s tilt were 15 degrees, the seasonal variations in weather would be __________ compared to how they are now.
   a. less extreme.
   b. more extreme.
   c. unchanged.

9. The Moon goes from full moon through all its phases and back to full moon in a period of time that is closest to a
   a. day.
   b. week.
   c. month.
   d. year.

10. During a solar eclipse, the
    a. Earth is in the Sun’s shadow.
    b. Moon is in the Earth’s shadow.
    c. Moon is in the Sun’s shadow.
    d. Earth is in the Moon’s shadow.
11. A waxing crescent moon will set at what time?
   a. 9 pm
   b. 12 am
   c. 6 am
   d. 9 am

12. A constellation is directly overhead at midnight on June 1\textsuperscript{st}. At midnight on December 1\textsuperscript{st}, the constellation will be
   a. directly overhead.
   b. rising.
   c. setting.
   d. not visible.

13. Who developed 3 laws to describe the motion of the planets around the sun?
   a. Aristotle
   b. Newton
   c. Galileo
   d. Ptolemy
   e. Kepler

14. A star that rises at 9 p.m. today will rise ________ tomorrow.
   a. earlier
   b. the same time
   c. later

15. **True or False:** The moon orbits the earth in the exact same plane as the earth orbits the sun.
   a. True
   b. False

16. Which of the following is NOT a result of a collision in our solar system?
   a. Jupiter’s red spot.
   b. The formation of our Moon.
   c. The tipped rotation axis of Uranus.
   d. The rings of Saturn.

17. The earth completes one orbit around the sun in
   a. one second.
   b. one day.
   c. one month.
   d. one year.

18. What causes winter to be cooler than summer?
   a. The Earth is closer to the Sun in summer than in winter.
   b. The daylight period is longer in summer.
   c. The Sun gets higher in the sky in summer.
   d. both B and C.
   e. all of the above.

19. Two burners on a stove have the same size. Burner 1 is on low, and burner 2 is on medium. Which burner has a higher energy output?
   a. Burner 1
   b. Burner 2
   c. Not enough information to tell

20. The most likely place where other life might exist in our solar system is on
   a. Mercury.
   b. Venus.
   c. the Moon.
   d. Mars.

21. Sunspots appear to move across the surface of the sun mainly because
   a. they are carried along with convection currents.
   b. the earth rotates around the sun.
   c. the sunspots follow an 11 year cycle.
   d. the sun rotates on its axis.
22. Which type of main sequence star has the shortest lifetime?
   a. O  
   b. G  
   c. K  
   d. A

23. The distances of nearer stars may be measured by observing their apparent motion as
   a. the Earth orbits around the Sun.  
   b. the Earth rotates on its axis.  
   c. the Sun orbits around the center of the Galaxy.  
   d. the planets cross their path.

24. If two intrinsically identical stars are at different distances from the Earth, the more distant star will have
   a. bluer color.  
   b. higher luminosity  
   c. lower luminosity  
   d. lower apparent flux.

25. A hot, glowing, opaque solid surrounded by a cool gas will show
   a. continuous emission.  
   b. emission lines.  
   c. absorption lines.  
   d. both emission lines and absorption lines.

26. The energy emitted by the Sun is produced
   a. in a very small region at the very center of the Sun.  
   b. uniformly throughout the whole Sun.  
   c. throughout the whole Sun, but more in the center than at the surface  
   d. from radioactive elements created in the Big Bang.

27. If any and all fusion suddenly stopped in the sun, the sun would
   a. remain the same size.  
   b. collapse.  
   c. expand slowly until it engulfs the earth.  
   d. explode.

28. Which is the correct order for the layers of the sun’s atmosphere, from inner most to outer most:
   a. Photosphere, chromosphere, corona  
   b. Corona, photosphere, chromosphere  
   c. Chromosphere, photosphere, corona  
   d. Photosphere, corona, chromosphere

29. The Hubble Space Telescope was named for Edwin Hubble because
   a. he made the first telescope.  
   b. he made the first telescope in space.  
   c. he was the first astronaut to fly the space shuttle.  
   d. a main goal of the telescope is to measure the Hubble contant.

30. The current age of the Universe is closest to
   a. 14 million years.  
   b. 4 billion years.  
   c. 14 billion years.  
   d. 140 billion years.

31. Which wavelength is NOT able to penetrate Earth’s atmosphere at all?
   a. Visible light  
   b. Radio  
   c. Gamma rays  
   d. Ultraviolet radiation

32. What are Jupiter and Saturn made mainly of?
   a. Hydrogen and helium  
   b. Methane, ammonia and water  
   c. Hydrogen and ammonia  
   d. Nitrogen and oxygen
33. Resolving power of a telescope is the ability
   a. to collect light and scales with the area of the primary mirror or lens.
   b. to collect light and scales with the diameter of the primary mirror or lens.
   c. to separate two objects and scales with the area of the primary mirror or lens.
   d. to separate two objects and scales with the diameter of the primary mirror or lens.

**Figure 1:** Answer the next three questions using this diagram.

34. According to Figure 1, what gases would you expect to find in Mercury’s atmosphere?
   a. H₂
   b. He
   c. N₂
   d. CO₂

35. The Hubble diagram is a plot of
   a. velocity versus distance of galaxies.
   b. velocity versus distance of stars.
   c. magnitude versus size of stars.
   d. luminosity versus temperature of galaxies.

36. The big bang refers to
   a. the beginning of the solar system.
   b. the beginning of the Universe.
   c. an explosion that occurs when a massive star reaches the end of its life.
   d. an explosion that occurs when a white dwarf accretes more mass than it can support.

37. Astronomers now know that the Universe will
   a. eventually collapse back in on itself in a big crunch.
   b. expand at a constant rate forever.
   c. expand at a faster and faster rate forever.

38. The sun is located
   a. in the disk of the Milky Way, but not at the center.
   b. in the halo of the Milky Way.
   c. in a globular cluster.
   d. at the center of the Milky Way.
Base your answers to this and the next 2 questions on the diagram below.

![Energy Output vs Wavelength Graph]

39. Which star has a higher surface temperature?
   a. Star A
   b. Star B
   c. They have the same temperature.
   d. Can’t tell from this graph.

40. Which star is larger?
   a. Star A
   b. Star B
   c. They have the same size.
   d. Can’t tell from this graph.

41. The greenhouse effect
   a. is observed only on earth and nowhere else in the solar system.
   b. is caused by too much nitrogen in our atmosphere which is produced by burning fossil fuels.
   c. is of no benefit to earth and we should do all that we can to eliminate it.
   d. keeps the earth’s temperatures moderate if the amount of greenhouse gases do not increase dramatically.

**Long Answer:** Answer the following questions. Use complete sentences and be sure to express complete thoughts.

1. Draw a diagram of the earth, moon, and sun that depicts the 8 major phases of the moon. Show what the moon looks like from earth for each phase. (10 points)

2. Draw a diagram showing a lunar eclipse. Clearly label the Earth, Moon, and sun as well as the umbra and penumbra. Explain the difference between a total and partial lunar eclipse. Explain why we don’t have a lunar eclipse every month. (10 points)

3. Draw a diagram of a spiral and elliptical galaxy. What are the distinguishing features of each type of galaxy in terms of age of stars and gas content. Are all galaxies either spiral or elliptical? Explain. (10 points)

4. Draw a diagram of the Milky Way. Label the disk, halo, bulge and globular clusters. Compare the age of stars that are located in the disk, halo and bulge. Give the diameter of the Milky Way. Label the position of the sun. (10 points)
5. Explain what a planet, star, and galaxy are. What are their sizes relative to one another? How do they relate to one another? Which does the Universe contain more of? (10 points)

   a. Label the horizontal and vertical axis. Label the main sequence, red giants, supergiants, and white dwarfs. (8 points)
   b. Draw the path of Sun on your H-R diagram as it evolves from protostar to its final end state. (4 points)
   c. Explain what is happening at each point in the Sun’s evolution. Be sure to explain why the transition to each new evolutionary state changes the sun’s location on the H-R diagram. (8 points)

7. The Planets
   a. What are the Terrestrial and Jovian planets? List the members of each group and describe the characteristics that the members of each group have in common. (10 points)
   b. How does the temperature of the solar system during planet formation explain the composition of the terrestrial and jovian planets and their location relative to the sun? (6 points)
   c. Are there any planets that don’t fit neatly into these two groups? Why? Explain. (5 points)

8. Answer either part a or part b. (6 points)
   a. The Hubble space telescope is in need of repair, and astronomers and politicians are currently debating whether or not to send a Shuttle mission to service the telescope and extend its lifetime.
      i. Give 3 reasons for saving the Hubble Space Telescope.
      ii. Give 3 reasons for letting Hubble die.
   b. President Bush would like NASA to pursue a manned mission to Mars in the next few decades, and astronomers are currently debating the merit of such a mission.
      i. Give 3 reasons for a manned mission to Mars.
      ii. Give 3 reasons against a manned mission to Mars.

9. Describe in detail two separate techniques for measuring distances to stars or galaxies. Be sure to describe how they each technique gives a distance. Use diagrams to aid in your explanation. (10 points)

10. What did you think was the most interesting part of the course? What was the least interesting? Explain. (4 points)